IESM Seminar: Unmanned Aerial Vehicles (UAV's)

Instituto de Estudos Superiores Militares
Lisbon, 15th December 2009

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sg@fe.up.pt

OUTLINE

1. Brief presentation of INEGI

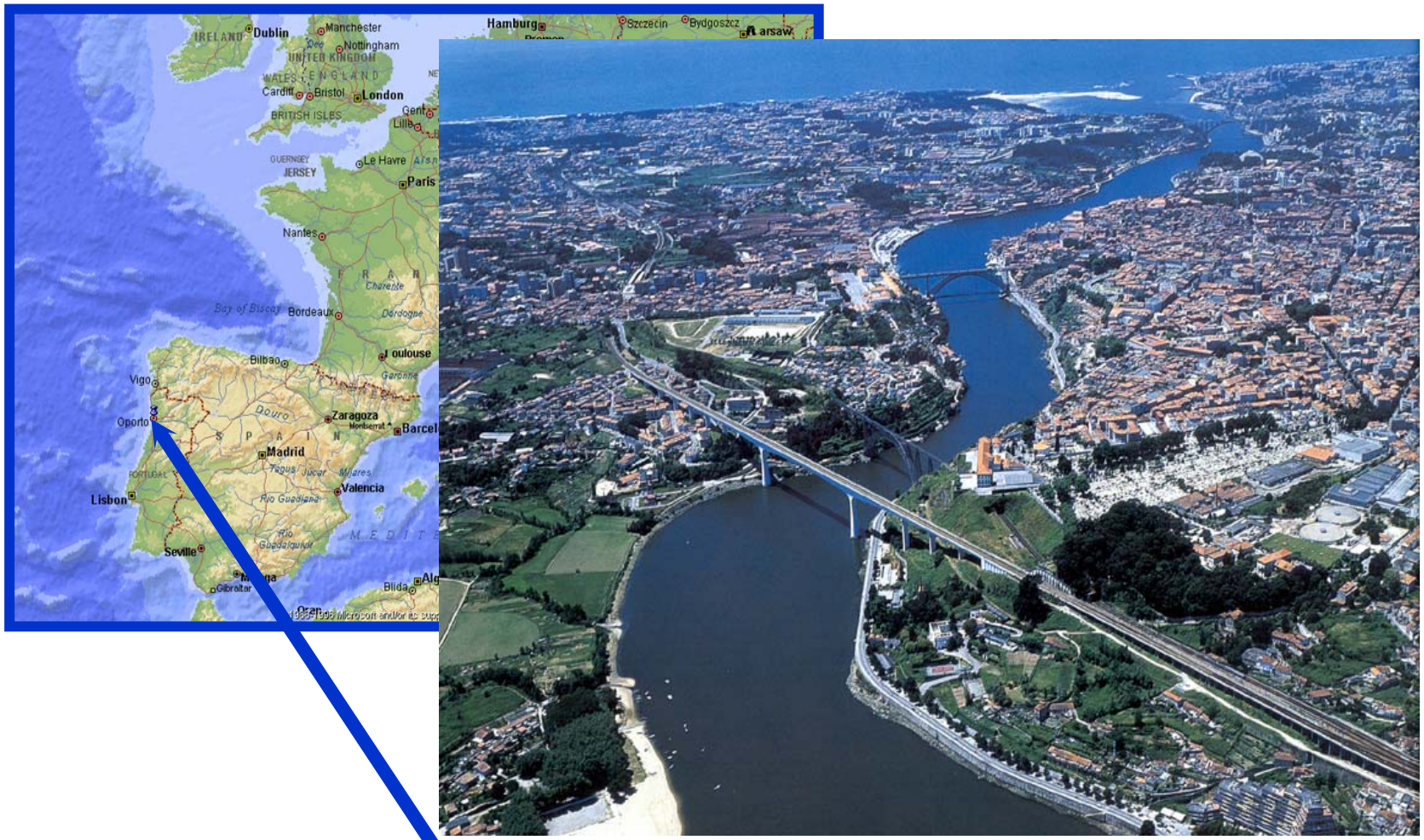
2. Competences and Activities in Aeronautics

3. UAV's and Related Equipments

4. Conclusion

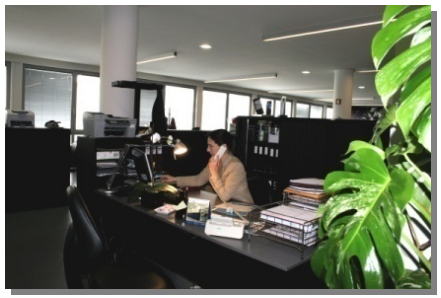
1. BRIEF PRESENTATION OF INEGI

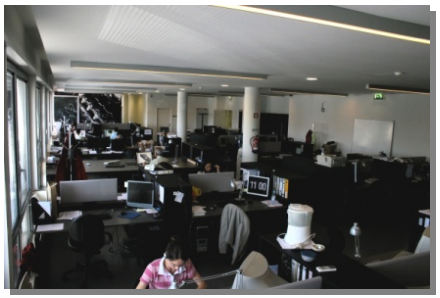
LOCATION (1)


Dublin
Manchester
Nottingham
Cardiff
Bristol
London
Le Havre
Paris
Nantes
Bordeaux
Bilbao
Vigo
Oporto
Zaragoza
Madrid
Valencia
Lisbon
Seville
Gibraltar
Hamburg
Szczecin
Bydgoszcz
PORTO – PORTUGAL

LOCATION (2)

INEGI's FACILITIES





POSITIONNING

- It is a private non-profit organization and recognized by the Portuguese Government as an Institution of Public Utility.
- Shareholders:
  - 33% - University of Porto
  - 6,8 % - FEUP
  - 60,2% - 60 private companies and 3 associations representing industry sectors
- It is positioned as an institution of interface with a strong link to both University and Industry.

MISSION

Contribute to the increase of industry competitiveness, through R&D, Knowledge and Technology Transfer and Training, in the fields of engineering, design, materials, production technology, energy and industrial management.

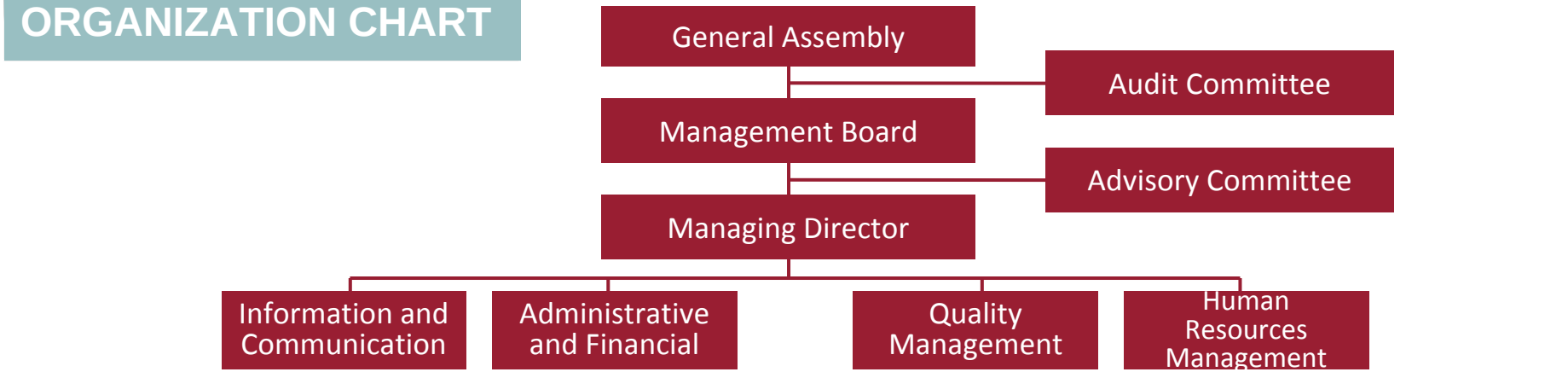
ACTIVITY IN FIVE MAIN AXIS

- Knowledge creation and development of technologies, usually 100% funded by FCT (National Foundation for Science and Technology) and EC.
- R&D projects with industry co-financed by Portuguese and European funds.

60% of total Revenues (2008)

- R&D projects with industry funded by clients.
- Technical consulting.
- Training – tailor made training programs, mostly “in-company”.

ORGANIZATION CHART



R&D

APPLIED RESEARCH

LAETA*

- Foundry, Rapid Prototyping & Rapid Tooling
- NDT and Experimental Mechanics
- Sheet Metal Forming
- Instrumentation Automation and Control
- Composite Materials and Structures
- Energy and Environmental Engineering
- Tribology, Vibrations and Industrial Maintenance
- Industrial Engineering and Management

ITT

INNOVATION & TECHNOLOGY TRANSFER

- New Technologies and Industrial Processes
- Product Design and Development
- Technologies for Sustainability
- Innovation Management
- New Technologies for Energy Production

CONSULTING

SCIENTIFIC/TECHNICAL CONSULTING & SERVICES

- Renewable Energies
- Environmental Solutions
- Rapid Prototyping and Rapid Tooling
- Smoke and Fire Behaviour of Products
- Tailor Made Training Programmes
- Technical Design Standardization (National Commission)

***Associate Laboratory for Energy, Transports and Aeronautics**

APPLIED RESEARCH		INNOVATION & TECHNOLOGY TRANSFER	SCIENTIFIC/TECHNICAL CONSULTING & SERVICES
Foundry, Rapid Prototyping & Rapid Tooling	NDT and Experimental Mechanics	New Technologies and Industrial Processes	Renewable Energies
…	…	…	…
Tribology, Vibrations and Industrial Maintenance	Industrial Engineering and Management	Innovation Management	Technical Design Standardization (National Commission)

SPIN-OFF

INDUSTRIES

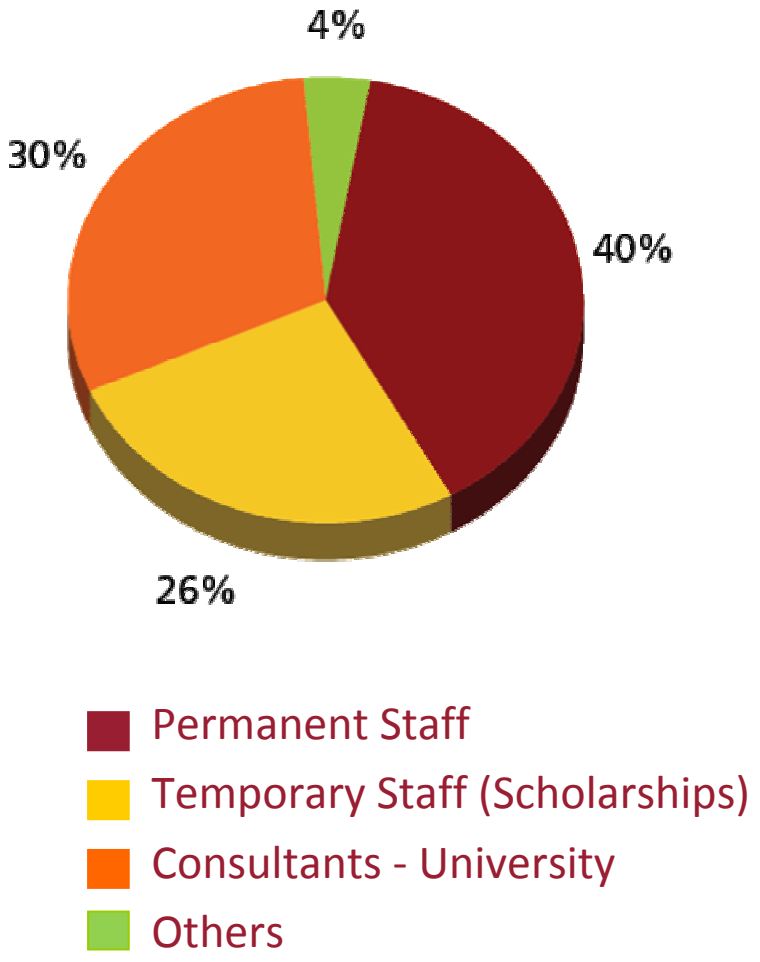
- AERONAUTICS AND SPACE
- AUTOMOTIVE, TRANSPORTS
- ENERGY
- TECHNOLOGIES FOR RESEARCH AND ECONOMIC EXPLOITATION OF THE OCEAN
- CAPITAL GOODS
- METALWORKING
- ENVIRONMENT
- HEALTH – DIAGNOSYS EQUIPMENTS, MEDICAL TOOLS AS TECHNICAL DEVICES
- MANUFACTURING

PARTNERS (List not exhaustive)

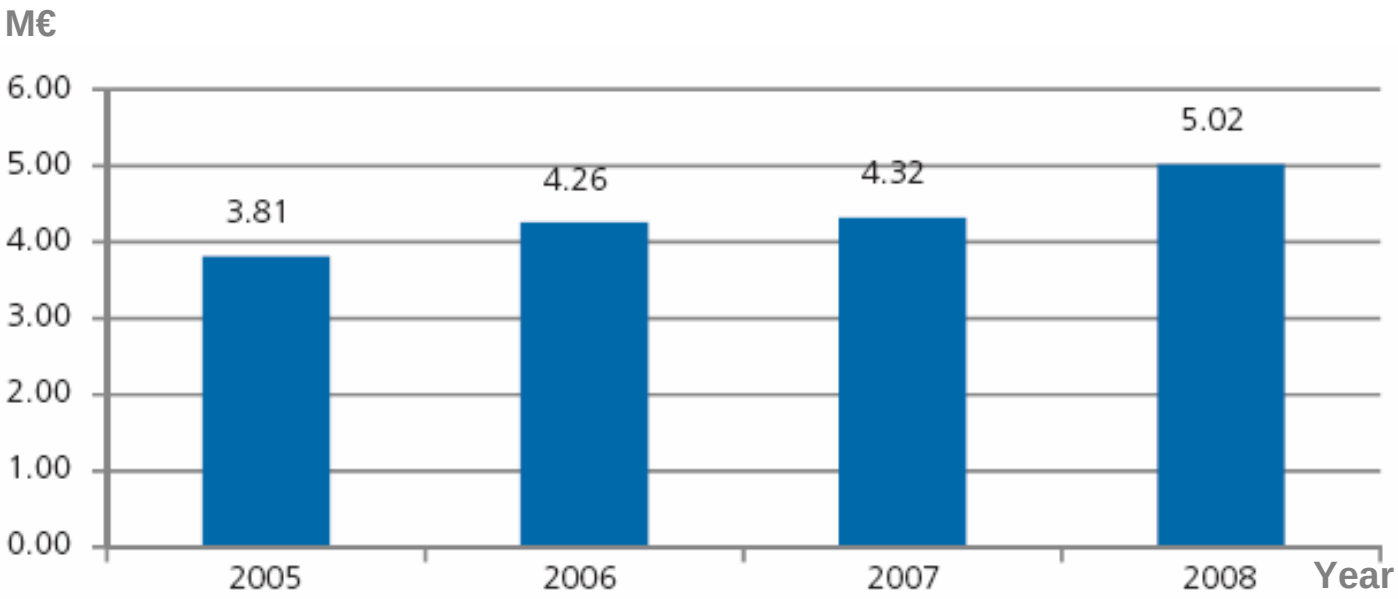
A.BRITO (PT)
ADRIA Airways (IT)
Aerospatiale (FR)
AIRBUS (UK)
BAe Systems (UK)
BOSCH (DE)
BUEHLER (DE)
CASA-EADS (SP)
CERN (CH)
CETIM (FR)
CIT (UK)
COMTEC (DE)
CSL (BE)
Deutschland GmbH (DE)
EADS (DE)
EFACEC (PT)
EMPA (CH)
ENSAM Bordeaux (FR)
ESA (FR)
FCT-U. Coimbra (PT)
FIAT (IT)
Hellenic Aerospace (GR)
IFW Dresden (DE)
IMMG (BE)
INASMET (SP)
INESC-U. Porto (PT)
INSA-Lyon (FR)
ISL (FR)
IST-T.U. Lisbon (PT)
ITO-Univ. Stuttgart (DE)
LABEIN (SP)
LEICA Optics (DE/PT)
Lufthansa Technik (DE)
Messier-Bugatti (FR)
MIT (USA)
MONITION (UK)
Nanyang T.U (SG)
NASA (USA)
NOLIAC (DK)
Nottingham Univ. (UK)
OGMA (PT)
ONERA (FR)
PSA (FR)
RENAULT (FR)
SAGEM SD (FR)
S- Caetano IMVT (PT)
SAMTECH (BE)
SKODA Vyzkum (CZ)
TAP-Portugal (PT)
TEKNIKER (SP)
THALES (FR)
TNO (NL)
TUDelft (NL)
UA-U. Aveiro (PT)
UM-U.Minho (PT)
University Carlos III (SP)
University of Paderbon (DE)
University of Toronto (CA)
VIDROPOL (PT)
VULCANO-BOSCH (PT)

HUMAN RESOURCES

75	Permanent Staff
50	Temporary Staff (scholarships)
125	**TOTAL BOARD**
57	Consultants - University
8	Others
190	**TOTAL**



TURNOVER

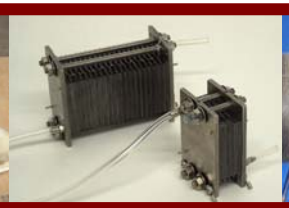

M€
6.00
5.00
4.00
3.00
2.00
1.00
0.00
3.81
4.26
4.32
5.02
2005
2006
2007
2008
Year

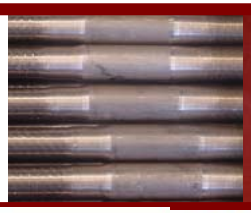


2. COMPETENCES AND ACTIVITIES

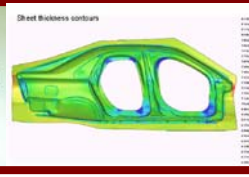
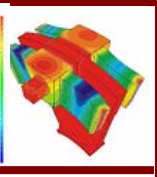
SUMMARY

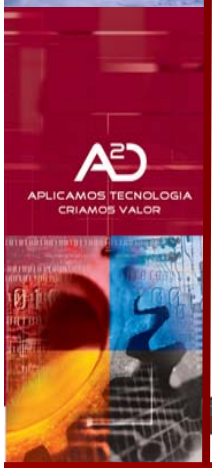






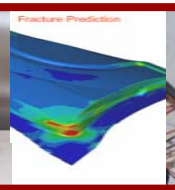







- 20 YEARS OF EXPERIENCE
- MORE THAN 2000 PROJECTS
- OVER 1000 PARTNERS/CLIENTS
- BUDGET OVER 60 M€






AERONAUTICS AND AEROSPACE PROJECTS

Non-conventional matrix/carbon nanotubes reinforced composite for applications in space- AO/1-5172/06/NL/SFe

The primary objective of the study is to develop novel composite materials using organic and inorganic matrices reinforced by carbon nanotubes.

INEGI's role is to perform a state-of-the-art study on the inorganic matrix carbon nanotube composite materials and to perform mechanical characterisation tests on specimens.

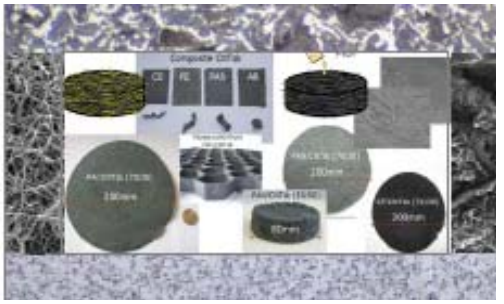
esa

HPS

AUSTRIAN RESEARCH CENTERS

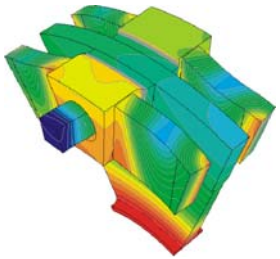
:FuturaCarbon

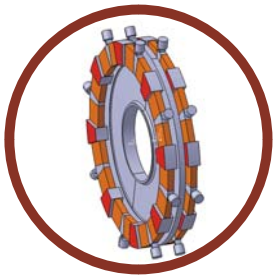
ASTRIUM

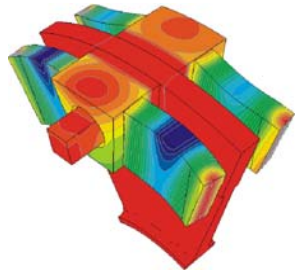


PIBRAC: Development of the next generation of brakes for aeronautics

Development of a new type of brakes based on piezoelectric engines



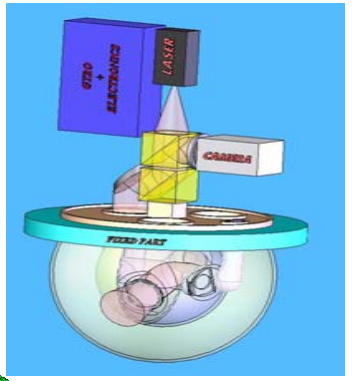




PARTNERS:

SAGEM
AIRBUS
MESSIER-BUGATTI
Universidade de Paderborn
SKODA
IMMG
SAMTECH
NOLIAC
BAM
A. Brito

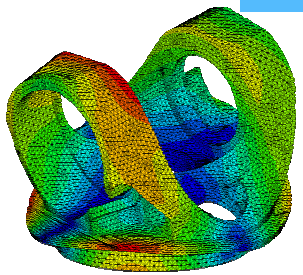
CASAM - Civil Aircraft Security Against Manpads

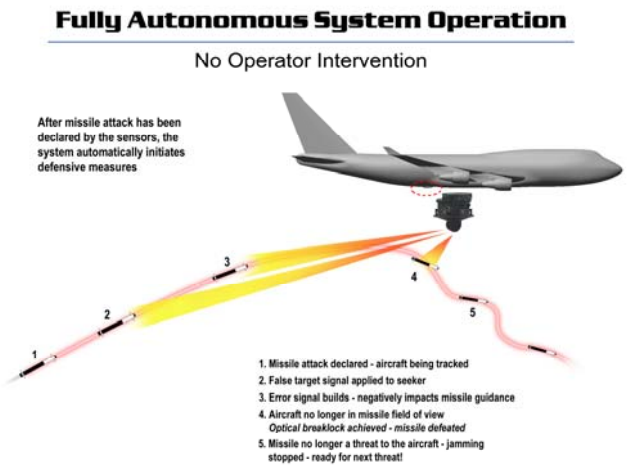


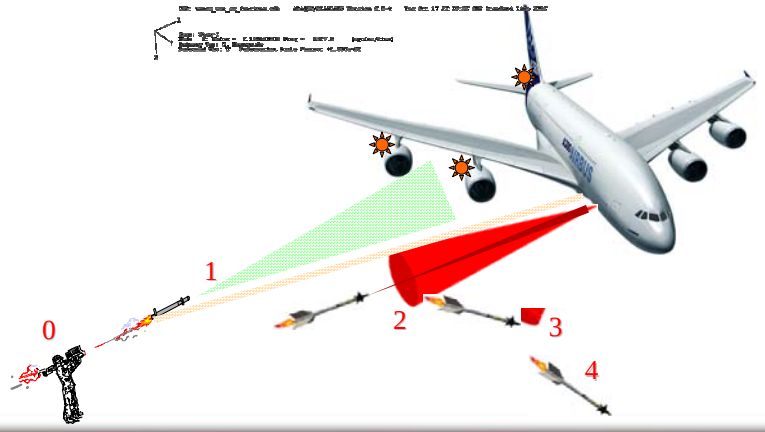
Description:

Development of a full autonomous Civil Aircraft Security Against MANPADS

Partners: **SAGEM-Défense et Secutité**
Airbus UK
EADS, etc…

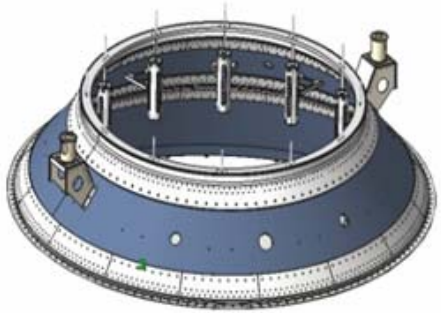


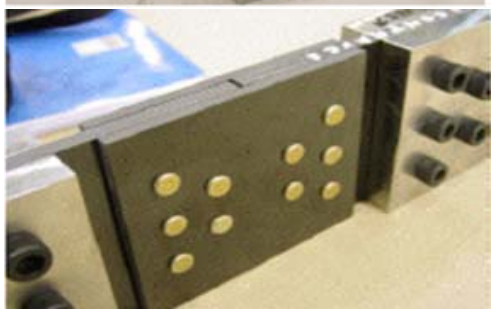




BOJO

- Development of hybrid composite materials (metal-carbon) to apply at overloaded joints
- Improvement of the resistance of mechanical joints made of advanced composites.
- INEGI´s role is to perform the necessary analysis and simulations to evaluate de behaviour of these materials



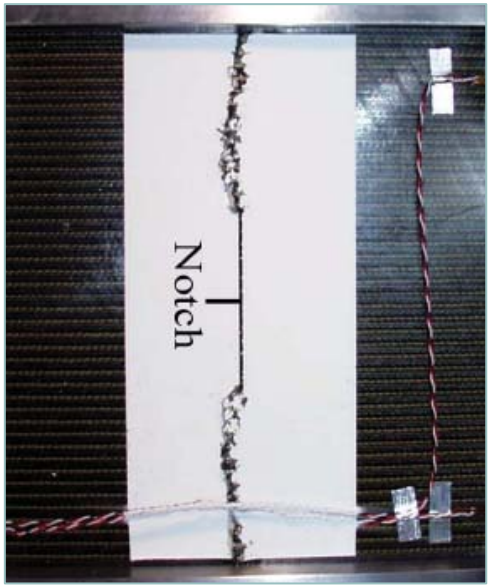


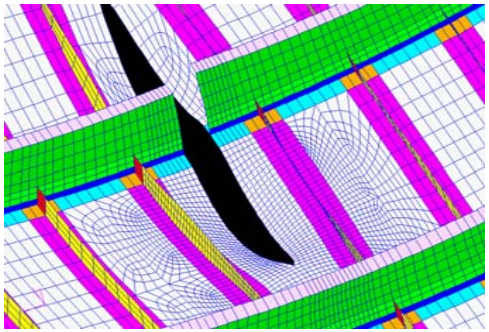
PARTNERS:
ESA
NASA
EADS
Air Force Research Laboratory;
HPS INVENT; KTH; LLB; DLR; MT Aerospace; Contraves;
CASA Espacio; Kayser-Threde; Saab; Ericsson Space

Progressive Failures Analysis of Advanced Composites

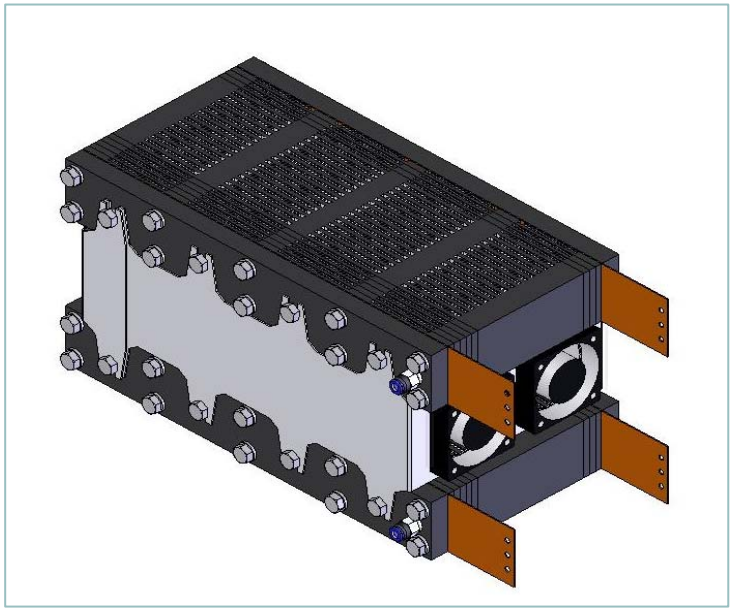
Development of computational models to simulate the mechanical behaviour of advanced materials.

The developed models were implemented in ABAQUS





PARTNERS:
NASA – Langley Research Center



EDEN
Solutions for the Hydrogen as an energetic vector

The main purpose of EDEN is to take advantage of the emergence of the Hydrogen Economy to stimulate the establishment of a national technological and economic platform in this area. This is achieved by promoting a strong cooperation between universities, research and technology organizations and enterprises, in testing and demonstrating actual applications of the technologies related to Hydrogen, in developing new scientific and technological competences as well as by setting up a national roadmap for the development of the Hydrogen economy

PARTNERS:
SRE, EDP,EEM, EFACEC,VIDROPOL,INETI, IST, AREAM

LUCIS

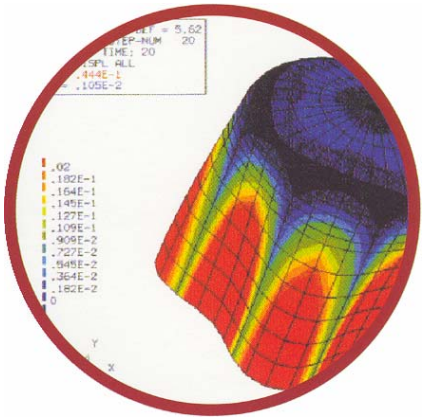
- Demonstration of Hydrogen Cells in Real Environment.
- This project aims to perform demonstration actions of the cell in different applications .



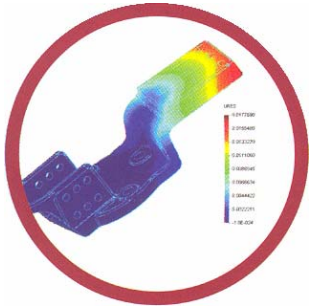
Product Development, Structural Health Monitoring & Manufacturing Capacities

STRUCTURAL ANALYSIS BY FEM:

Tank design in composite material (FRP)



Automobile brake pedal



Electric contactors support

Finite Element Analysis:

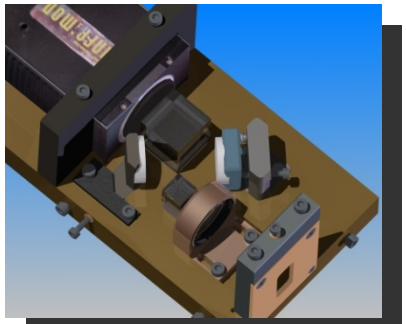
INEGI has significant experience in this area, gained through cooperation with companies from different sectors of activity.

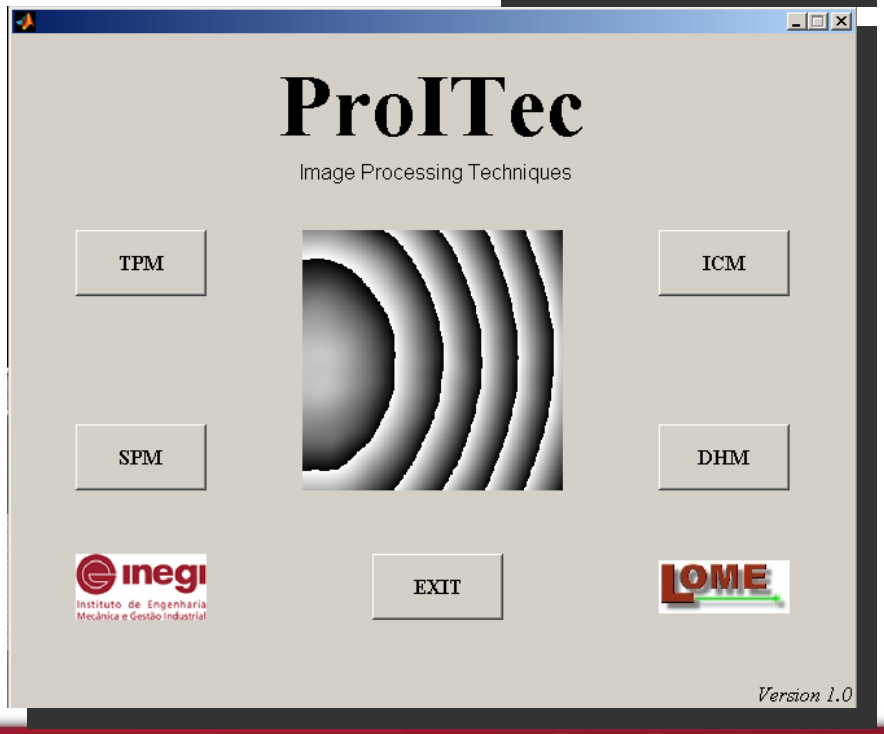
Currently, the development of new products uses advanced engineering techniques, among which the structural simulation by means of FEM:

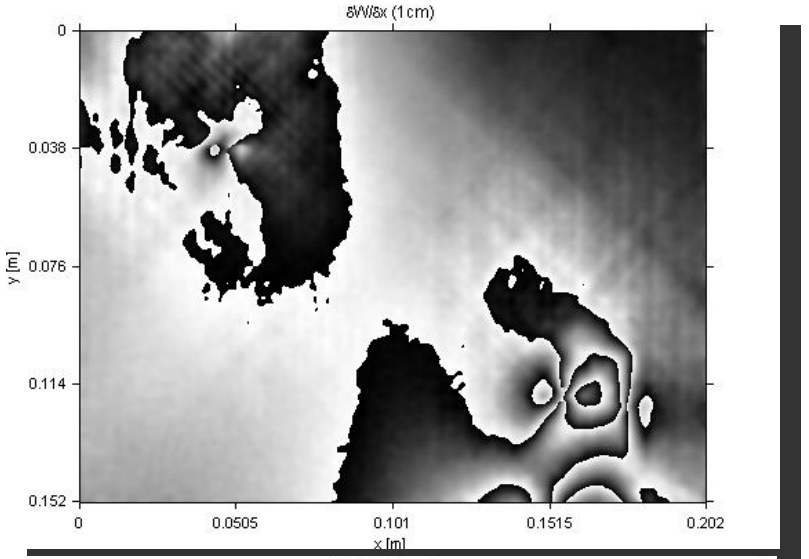
- **Elfen**
- **I-Deas**
- **Cosmos**
- **Abaqus**
- **Solid works**

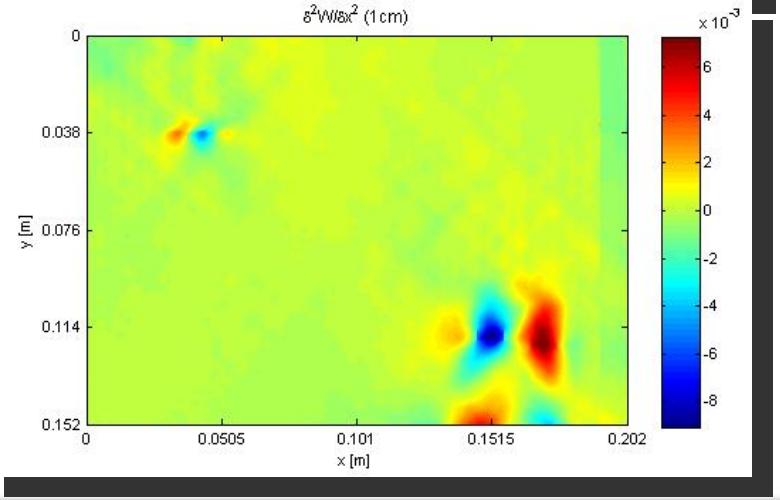
Simulation of damage in advanced composite structures

New Tools for Composites Inspection (1)
(Structural Health Monitoring)

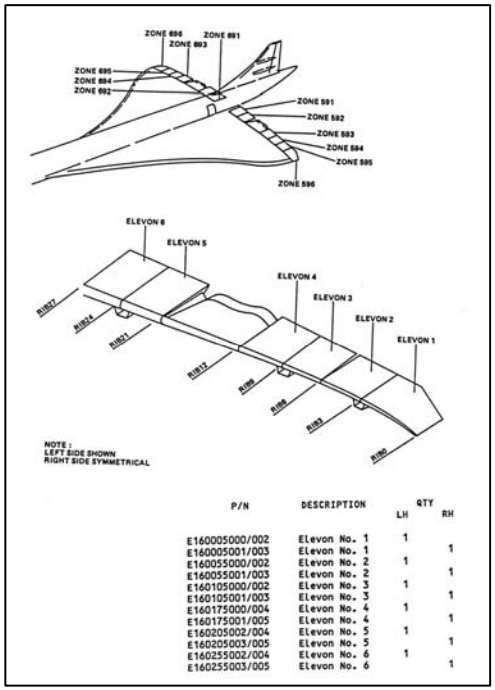








New Tools for Composites Inspection (2)
(Structural Health Monitoring)



P/N	DESCRIPTION	QTY LH	QTY RH
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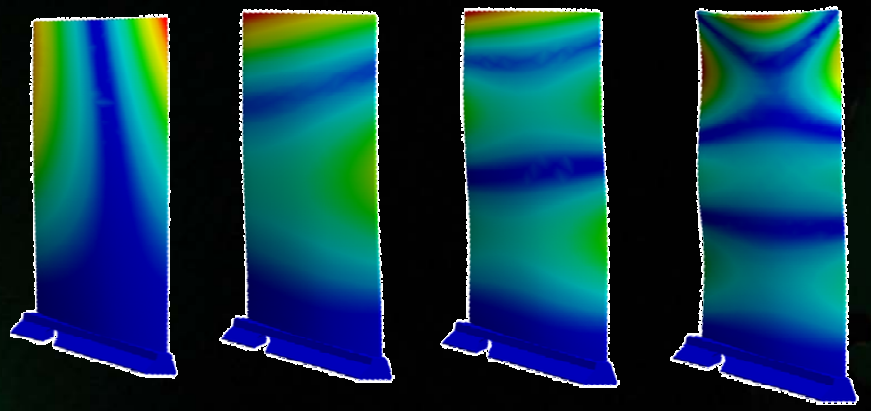
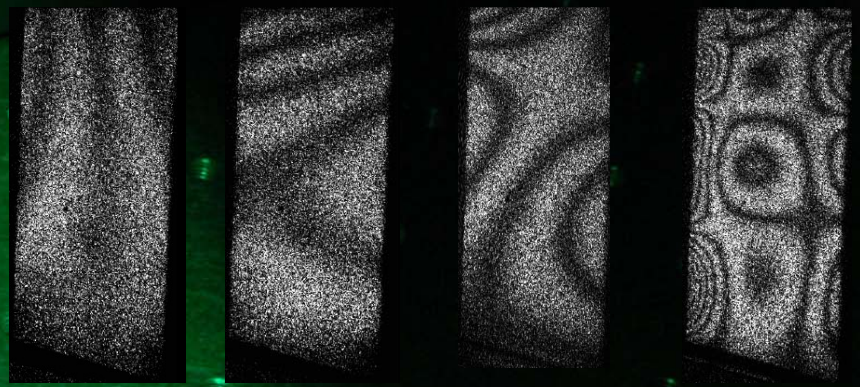
E160005001/003	Elevon No. 1		1
E160055000/002	Elevon No. 2	1	
E160055001/003	Elevon No. 2		1
E160105000/002	Elevon No. 3	1	
E160105001/003	Elevon No. 3		1
E160175000/004	Elevon No. 4	1	
E160175001/005	Elevon No. 4		1
E160205002/004	Elevon No. 5	1	
E160205003/005	Elevon No. 5		1
E160255002/004	Elevon No. 6	1	
E160255003/005	Elevon No. 6		1

New Tools for Mechanical Design
(Vibration Analysis)





Manufacturing Facilities (1) - Rapid prototyping & tooling

LOM rapid prototyping machine

LOM prototypes and foundry moulds

Conversion of prototypes in metallic parts

Types of Activities:

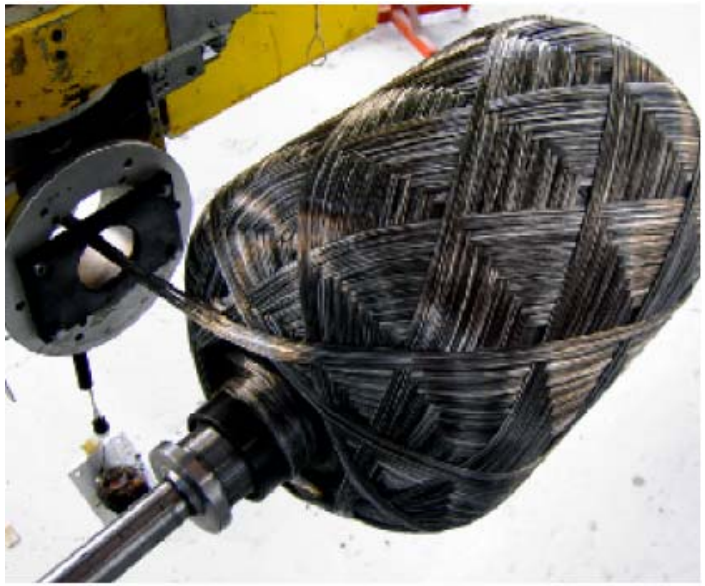
- Product Development
- Foundry tools design and optimisation
- Rapid prototyping LOM
- Pastic conversions in silicone moulds
- Pre-series of metallic products by investment casting
- Mechanical and metallurgical testing
- Special equipments design and prototyping

Plastic injection moulds for the automotive industry

Manufacturing Facilities (2) - RTPULTRU

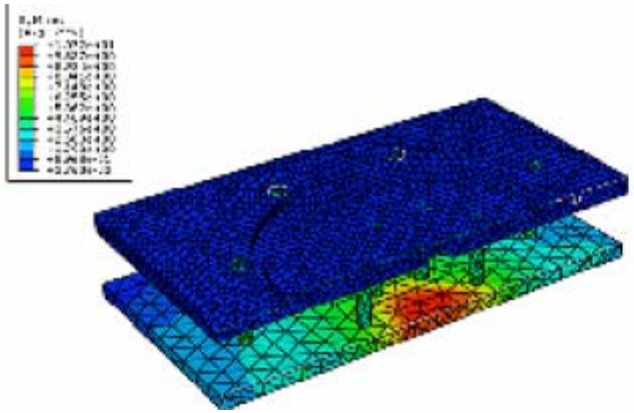
- Find an alternative for the conventional resin bath on the pultrusion manufacturing process.
- Eliminate the release of dangerous gases and reduce the excess of resin verified in this process

Manufacturing Facilities (3) - RESCOMPRE

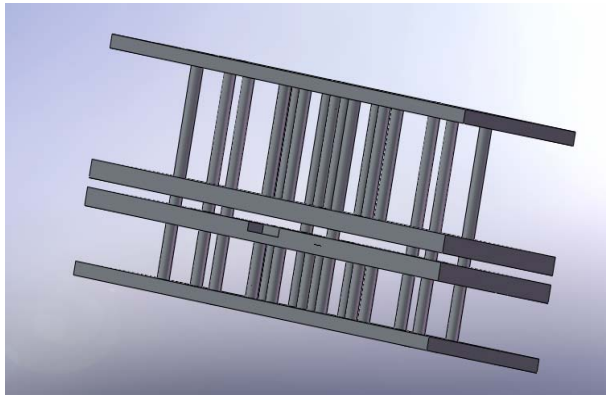


Optimization of the high pressure vessels structure using advanced calculus methods and mechanical testing like damage tolerance and durability.

Manufacturing Facilities (4) - NM RTM



- Development of a new manufacturing process. The architecture of this process of resin transfer moulding doesn't change so the name stays RTM
- The goal of this process is the manufacturing of high structural behaviour pieces.
- Change the viscosity of the resin with the intervention of nanoparticles and magnetic fields.



PARTNERS:

FEUP, AEFEUP, APDL

INTEGRATION CAPACITIES
Lusitano VIP Innovative Portuguese Sailing Ship

Lusitano VIP project's main purpose is to develop and build an innovative sailing ship with approximately 10 meters (33 feet) length, under the orientation of the shipbuilder Tony Castro. The project is being carried out by using the engineering capacities of FEUP, AEFEUP, INEGI, APDL, and with the participation of interdisciplinary teams composed by students and researchers in the following areas: materials, product development, numerical simulation and electronic sensors

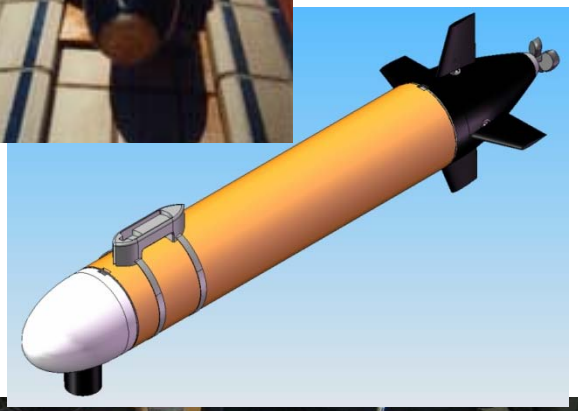


3. UAV's AND RELATED EQUIPMENTS

SEA TECHNOLOGIES | Vehicles (1):

Development /Mechanical Systems Construction and parts

AUV / L-AUV (Light - Autonomous Underwater Vehicle)



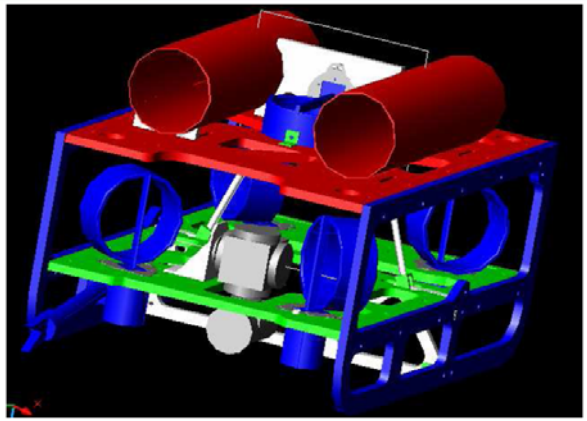
- Offshore verification of equipments and strutures
- Samples collection
- Levantamento do relevo do fundo do mar

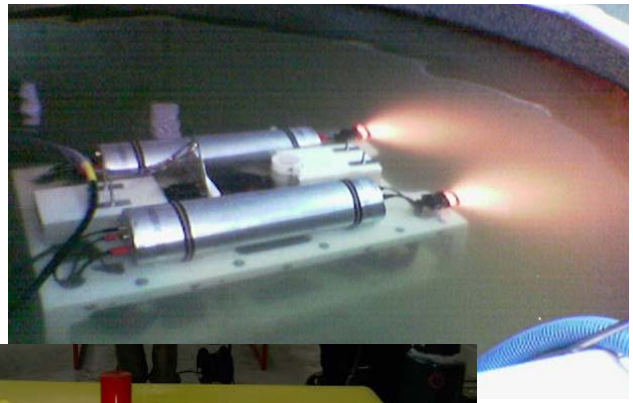
Project Lider: ISR

SEA TECHNOLOGIES | Vehicles (2):

Development /Mechanical Systems Constrution and parts

ROV (Remotely Operated Vehicle)





- Inspection and equipment assembly
- Remote observation of the deep
- Exploration in depth

Project lider: ISR

SEA TECHNOLOGIES | EQUIPMENTS

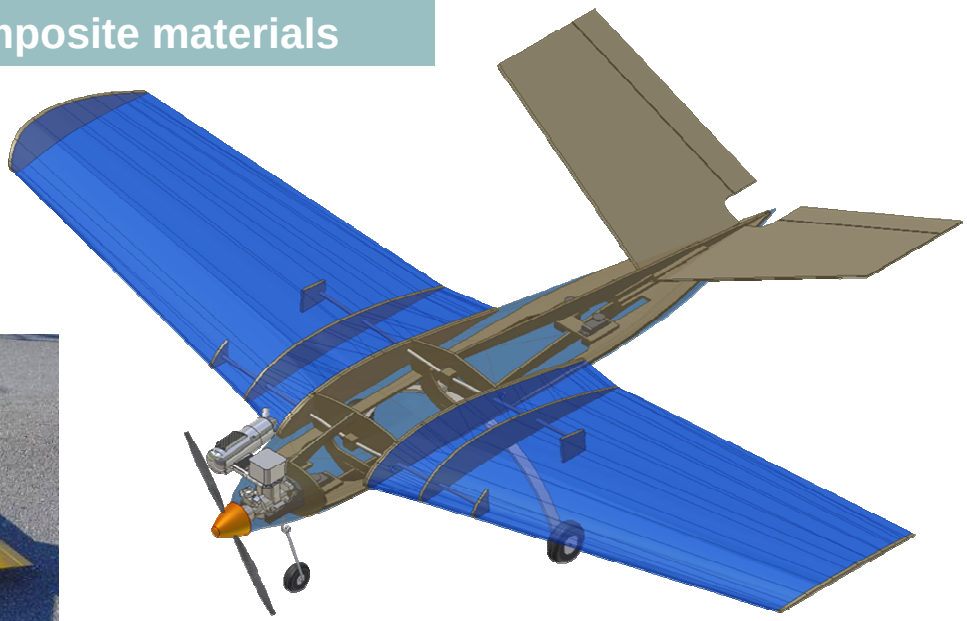
Composite materials processing techniques

OFFSHORE Floating Structures:

- Signalling and orientation
- Monitoring and atmospheric control
- Control and communication with vehicles

Partners: INTECMAR, INSTITUTO ESPAÑOL DE OCEONOGRAFIA, INSTITUTO DE INVESTIGACIONES MARIÑAS, CETMAR, UNIVERSIDAD VIGO, CIIMAR, INESC PORTO, FEUP, INSTITUTO HIDROGRÁFICO,UNIVERSIDADE DE AVEIRO, FCUP

UAV Systems (1):
Design/Manufacturing of airframe in composite materials



UAV (Unmanned Aerial Vehicles)

- **PITVANT**
- **PAIV**
- **STEPUAV**

Partners:
FEUP, AFA, INEGI, PEMA, SPINWORKS, EMPORDEF, ETC.

UAV Systems (2):
Design/Manufacturing of airframe in composite materials

BRUTUS

- 3.5 kg
- Carbon fibre on wood and expanded polystyrene

Partners:
FEUP, INEGI.

UAV Systems (3):
Design/Manufacturing of airframe in composite materials

FLYBY

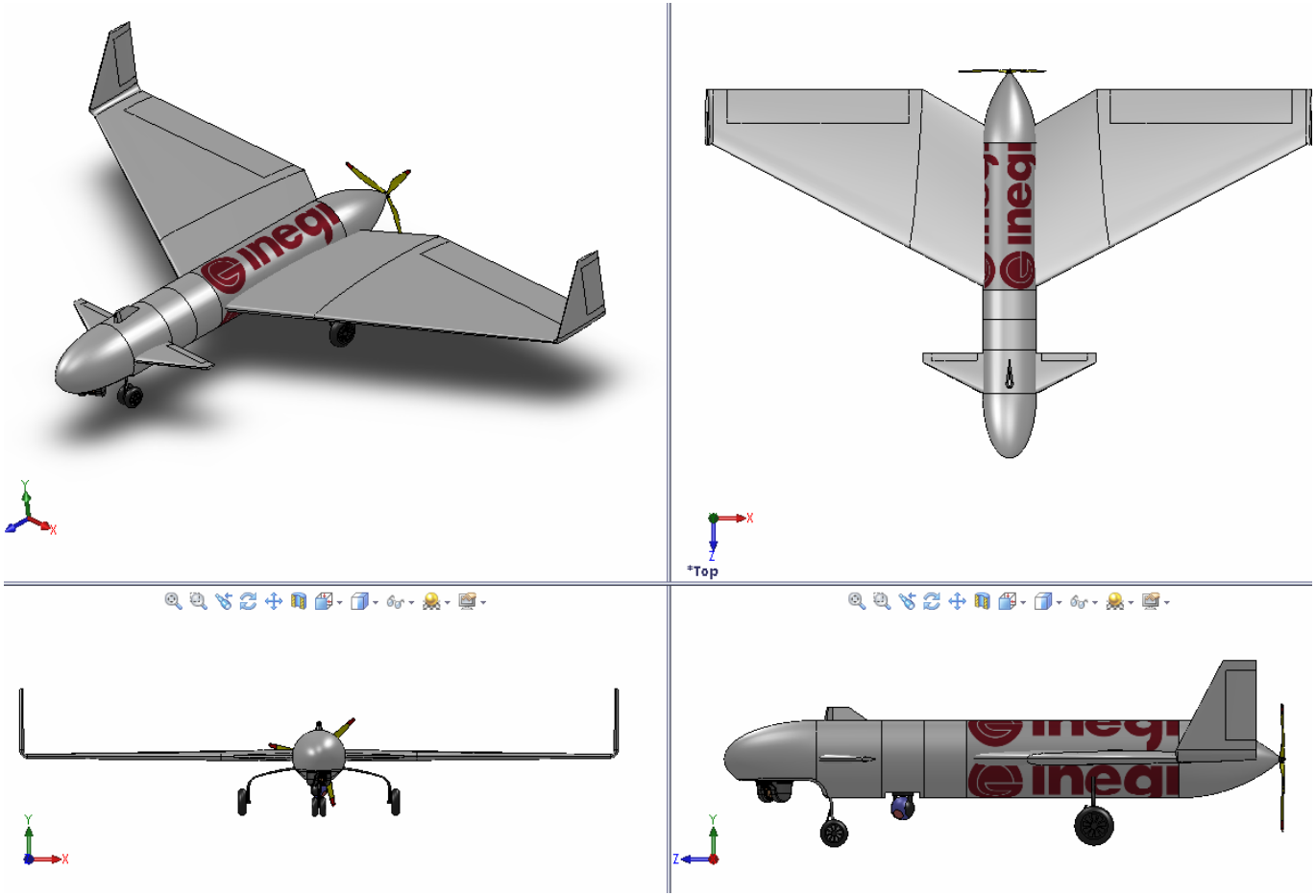
- Gross weight: 3.7 kg
- Payload capacity: 9,5 kg

Partners:
FEUP, INEGI.

UAV Systems (4):
Design/Manufacturing of airframe in composite materials

THE FUTURE

- Prototyping
- New design
- New materials

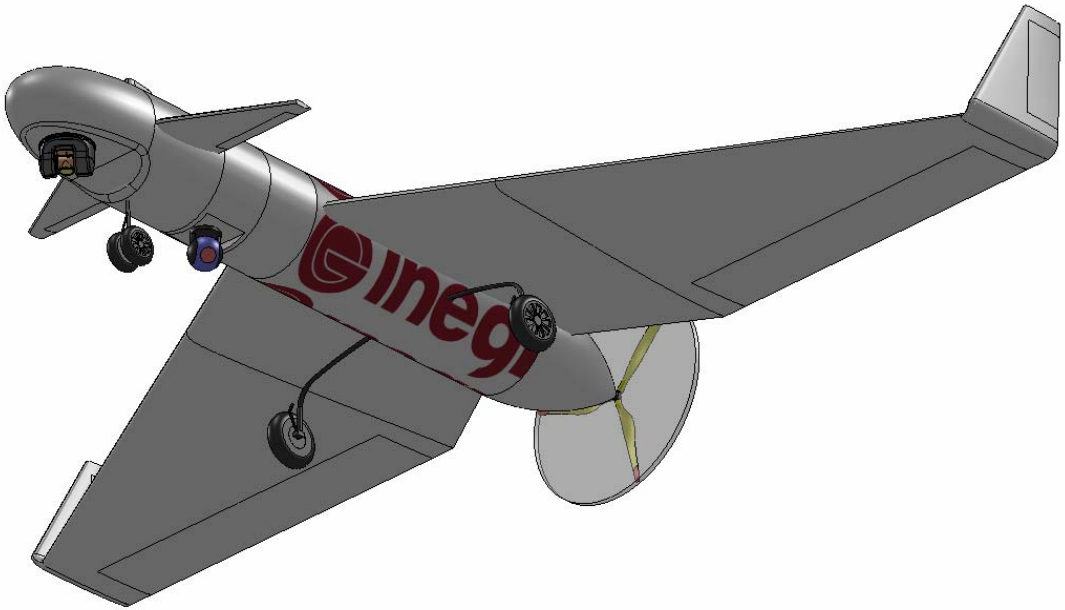


Partners:
FEUP, INEGI,
AFA, and others…

UAV Systems (5):
Design/Manufacturing of airframe in composite materials

THE FUTURE

- **Prototyping**
- **New design**
- **New materials**



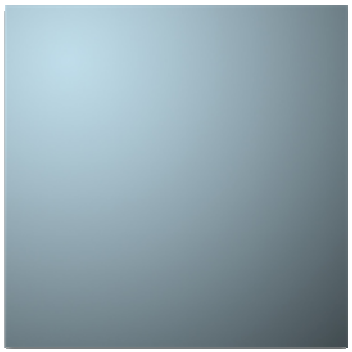
Partners:
FEUP, INEGI, AFA, ISEP, and others…

UAV Systems (6):
Design/Manufacturing of airframe in composite materials

THE FUTURE

- Coast surveillance
- Search and rescue
- Other missions

Partners:
FEUP, INEGI, AFA, ISEP, and others…



4. CONCLUSION

CAPACITY & EXPERTISE

INEGI has the capacity to bring innovative technical solutions to the challenges addressed by the actual needs for UAV development, as it did in many similar situations described above.

Across the last 20 years of its existence, INEGI has always honoured the commitments in the many private, national and international R&D programmes, and associated achievements, in which it has been involved.

Possible contributions to future UAV systems

INEGI • Platform (airframe)

•Automatic Pilot

INEGI • Power/energy

• Propulsion

INEGI • Actuators

• Communications

INEGI • Safety

•Computer

INEGI • Payloads

END

Thank you!

(www.inegi.pt)